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DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
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IRON OXIDE PIGMENTS AND MORTAR COLORS

BY

R. M. SANTMYERS

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By R. M. Santmyers[2]

CONTENTS

	Page		Page
Foreword	1	Tariff history	16
General description	2	Exports	16
Properties	5	Marketing and prices	17
Uses	5	Foreign countries	18
Substitutes	7	Spain	18
Sources of supply	7	Exports	21
Natural	7	Great Britain	22
Artificial or prepared	8	Imports and exports	23
Mining and preparation	8	Canada	25
Production	10	List of domestic producers, dealers, and importers	26
Imports	13		

FOREWORD

This is the third of a series of information circulars dealing with the subject of mineral pigments. The first, I. C. 6132, published in May, 1929, is entitled "Ocher and Ochery Earths" and the second, I. C. 6504, entitled "Umber, Sienna, and Other Brown Earth Pigments," was published in September, 1931.

Inasmuch as the nomenclature of these pigments is somewhat confused, one of the purposes of the present paper is to stimulate discussion with a view to clarifying the situation. The terminology herein employed is designed to follow commercial practice but is subject to correction.

1/ The Bureau of Mines will welcome reprinting of this article, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6627."

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GENERAL DESCRIPTION

The pigments, whose colors are due primarily to iron oxides and iron hydroxides, comprise a variety of yellow, brown, red, and sometimes black paint-coloring agents, both natural and artificially prepared. The natural pigments in this group include ocher, umber, sienna, mineral paints, paint rock, and mortar colors. When the natural color or tinting power--either in the raw state or after treatment--is too weak, these pigments may be "fortified" or strengthened.

Ocher, umber, and sienna, while often described as "iron oxide pigments," are also known as "earthy" pigments. Inasmuch as the iron content of these pigments is, in general, somewhat lower than that of other iron oxide pigments, the ochers, umbers, siennas, and other brown earth pigments are not discussed in the present paper. In addition to a discussion of natural or artificial pigments whose color is due to the presence of iron oxide in some form, this paper contains data on mortar colors, which are medium or low grade pigments used for tinting mortar, cement, and concrete. A great variety of materials are used for these purposes, including "blue billy" (residue left from roasting pyrite), ground slate and shale, and even culm from coal washeries. During the past three years, there has been a definite trend among the producers of iron oxide pigments to push the sales of the better grades of colors for tinting mortars. Due to the amount of low-grade coloring matter that is required to impart a strong color to concrete (in some cases as high as 15 per cent of pigment is necessary) the strength of the cement may be materially impaired. The addition of some 2 per cent of the higher grades of iron oxide to the concrete mix imparts a brighter and stronger color, does not weaken the material, and in the end is not as expensive as the low-grade pigments formerly used.

Iron oxide pigments occur in nature in various shades and colors, but the red pigments are the most important and account for the larger part of the total red pigments used.3/

The nomenclature of these red pigments is involved and the names given to them are descriptive of the shade rather than of origin, method of production, or chemical composition. In most cases the red pigments under this class may occur naturally or may be produced by heating hydrous iron oxide pigments such as yellow ocher to a sufficiently high temperature to drive off the water of composition. They may also be prepared by fortifying naturally-occurring pigments with stronger natural or synthetic oxides or with coal-tar dyes (e.g. alizarine lake).

Most of the mineral reds derive their color from the presence of ferric oxide (Fe_2O_3), the mineral hematite. This may be present in relatively small percentages, as in the red slates and shales, or it may constitute as much as 90 per cent or more of the material, as in Spanish red.

The principal iron oxide pigments used in the manufacture of paint are discussed in the following pages.

3/ Toch, Maximilian, The Chemistry and Technology of Paints: New York, 1925, p. 62.

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Persian red or crimson oxide (the original Indian red) contains 65 to 70 per cent of Fe_2O_3 and comes from Ormuz Island in the Persian Gulf. A somewhat similar natural product is now produced in this country, in Pennsylvania.

Spanish red is a nearly pure soft red usually containing 80 to 90 per cent of Fe_2O_3.

Purple oxide or Indian red (natural) approximates Spanish or Persian red in composition, and is used straight as a cheap Indian red or as an adulterant in true Indian red.

Canadian red is a calcined limonite ore very high in ferric oxide (up to 98 per cent Fe_2O_3).

Indian red and Turkey red are made by roasting copperas (iron sulphate) crystals, produced as a by-product from pickling liquors in wire or galvanizing mills. They are very high grade and are two of the most important of the red pigments. Indian reds are produced by higher heating of Turkey reds and are definitely purple in tone and tint. The Turkey reds are the brighter, cleaner, and stronger shades.

Red oxide or oxide of iron, as the terms are generally understood, is made in the same manner as Indian red, but is lighter in shade. These terms are also used rather loosely to apply to various types of natural red pigments high in ferric oxide.

Venetian red[4/] is a term loosely applied to a variety of the red iron oxide pigments, varying in chemical composition. The only distinction the name implies is that the pigment is light-red in contrast to darker iron oxide pigments, chiefly Indian red. Some writers state that the term should be restricted to pigments composed of a mixture of iron oxide and calcium sulphate, produced by neutralizing pickling liquors with lime and calcining the residue. Under this latter definition Venetian reds contain 20 to 40 per cent of iron oxide (Fe_2O_3) and 60 to 80 per cent of calcium sulphate ($CaSO_4$). On the other hand, catalogues of manufacturers show Venetian reds containing 12 to 40 per cent of ferric oxide and the remainder made up of varying percentages of calcium sulphate, calcium carbonate, and magnesium silicate.

This indicates that the term "Venetian red" includes pigments made by grinding iron oxide with fillers (calcium carbonate, magnesium silicate, gypsum, or calcium sulphate) or by reducing true Venetian red, a mixture of iron oxide and calcium sulphate produced by precipitation and calcination, by grinding with these fillers. The specifications of the United States Government recognize only two ingredients in Venetian red, ferric oxide and calcium sulphate, and specify three grades of this pigment containing 40 and 60, 30 and 70, and 20 and 80 per cent of ferric oxide and calcium sulphate, respectively. It is evident that Venetian red may be described as a mixture of iron oxide and calcium sulphate. Venetian red is one of the cheapest of the iron oxide pigments.

4/ U. S. Tariff Commission, Pigments, Paints and Varnishes: Tariff Information Surveys, A-15, 1922, pp. 89-90.

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Tuscan red[5] although classed as an iron oxide pigment depends upon coal-tar dyes for its depth of color. It is generally a shade of Indian red made by toning up the color of a low grade of that pigment with a red coal-tar dye (alizarine lake).

Metallic paints[6] are iron oxide pigments which are higher in the oxide content than the ochers. "Metallic paints" as marketed usually contain from 33 to 64 per cent Fe_2O_3. They are made (1) by grinding together a mixture of ocher and limonite iron ore and burning to form a red product rich in iron, or (2) by calcining and grinding a natural iron carbonate (siderite) paint ore found only in the Lehigh Gap district of Pennsylvania.

Colcothar, rouge, caput mortuum, and crocus martis are similar to Indian red but do not enter in any large quantities into the manufacture of paints. The last-named is the designation for purple oxide of iron and is used primarily as a polishing and abrasive material.

There are a number of other red pigment materials used in the manufacture of paints, but as these are for the most part artificially prepared, they do not come under the scope of this paper.

The only brown iron oxide pigment of any importance (excepting the earth pigments, ocher, umber and sienna) is the metallic brown or mineral brown. This pigment is prepared by calcining an impure hydrous iron oxide (limonite iron ore). It usually contains from 40 to 75 per cent of ferric oxide, averaging 50 per cent. It is variable in color but resembles somewhat burnt sienna. Blast furnace dust, a grayish brown powder consisting of iron oxide and coke separated from gases at many furnaces, is ground to produce a seal-brown pigment. As this pigment contains some sulphur it is not suitable for iron paints.

Magnetite, magnetic iron oxide ($FeO.Fe_2O_3$), is the only iron oxide mineral used as a black pigment. Pure precipitated black magnetic oxide of iron has been widely recommended for use in cement work. Although its tinting strength is less than that of carbon blacks, it is said to be easier to work with cement due to its high specific gravity.

Mortar colors and ground slate and shale also contain iron oxide in varying amounts. The cheaper grades of iron oxides may be used as mortar colors but the tendency is to use the higher grades. From the standpoint of the paint trade, ground slate and shale may be divided into three classes--black, yellow, and red shales, the use to which they are put depending solely upon the color.

5/ U. S. Tariff Commission, Work cited, p. 90.

6/ Ladoo, R. B., Non-metallic Minerals, Occurrence, Preparation and Utilization: New York, 1925, p. 369.

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PROPERTIES

All pigments consist of three parts: (1) The principal color producing ingredient, which in the case of naturally-occurring red pigments is usually ferric oxide (Fe_2O_3), the mineral hematite, and in brown pigments is hydrous iron oxide or limonite ($2Fe_2O_3.3H_2O$), the same as hematite but containing 3 molecules of water; (2) the secondary or modifying color ingredient; and (3) the base, filler, diluent or carrier of the color.7/

Although a high content of iron oxide may improve the quality of the material for use in rust-preventing paints, it does not determine the other qualities of the mineral paints on which much of its value as a pigment depends. Even the brilliancy of color and staining or coloring power are not always in proportion to the content of iron oxide. Material containing low percentages of ferric oxide often is more brilliant in color and stronger in staining power and therefore worth more than other material containing higher percentages of iron oxide.

The base in practically all naturally-occurring iron oxide pigments is clay. The composition of clay varies widely, hence the base compositions of most iron oxide pigments may be quite different. This base composition, unlike that in artificial pigments, can only be changed or controlled by (1) selection or blending of varying proportions of the deposit and (2) by removal of some impurities by simple purification methods.

With artificial or prepared pigments any base or filler can be added to the hydrous oxide of iron or other coloring material, and the concentration of color-producing ingredient can be varied at will. The result is that the prepared pigments can be much more closely controlled as to color, opacity, covering power, etc., than those occurring naturally and therefore have been able to invade successfully the natural-pigment markets.

USES

The most extensive use of iron oxide pigments is in the manufacture of paints used chiefly for protecting iron and structural steel work from rust. They have proved more satisfactory than either graphite or red lead, which were formerly much used for this purpose. They are also very much cheaper in first cost.8/

The greatest permanence and protective power result when dark or red pigments are employed, therefore the comparatively cheap iron oxide pigments are well adapted for this purpose.

The proportions of pigment to oil are of importance when the paint is to be used for the protection of iron and steel, and in case of deep Indian red maximum efficiency is attained with 60 per cent of pigment, whereas red

7/ Wilson, Hewitt, Ochers and Mineral Pigments of the Pacific Northwest: Bull. 304, Bureau of Mines, 1929, pp. 10-11.
8/ U. S. Tariff Commission, Work cited, p. 91.

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lead paint requires 80 per cent of pigment.[9] The maximum protection coincides well with the ease of working, and two coats protect better than one. The cheapest and best way to prolong the life of the metal is to paint iron or steel structures while the scale is still on the surface after removing any loosely adhering flakes and rust.

Large quantities of iron oxide pigments are used for cheap paints on freight cars, barns, and temporary outdoor structures. Smaller quantities are used for coloring wall paper and as a coloring agent and filler in the manufacture of linoleum, composition flooring, oilcloth, imitation leather, rubber, and shade cloth. Other uses are in ceramics, kalsomine, shingle stain and paint, and paper and cardboard filler.

Fairly large quantities of Clinton hematite ground in oil have been used in the past for casting railway car wheels. When applied to the interior of the molds it imparts a deep chill to the surface of the wheels.

The higher grades of iron oxide are used as abrasives and for polishing. A finely divided form is known as "watch-case rouge." This, however, is nothing but pure Indian red which has been ground, washed, and treated mechanically with so much care that three-quarters of its selling price is represented in its final preparation.[10] This material is also known under the name of "crocus martis." Crocus cloth is similar to emery cloth but contains finely divided purple iron oxide as the abrasive medium.

Magnetite or black iron oxide is employed to only a slight degree as a paint pigment; it is used principally as an abrasive and polishing medium. The synthetic black oxide is employed as a pigment in cement work.

Chiefly the lower grades of iron oxide pigments are used for tinting mortar, cement, and concrete, and the colors are usually of the various shades of red, brown, purple, blue, and black. As marketed, most of the colors are blends or mixtures. There is a growing tendency, however, to use the higher-grade pigments.

Ground slate and shale are used in paints and as fillers in the manufacture of oilcloth and linoleum. Black shales are used to some extent in paint for buildings, but chiefly in the manufacture of a black filler for iron work.[11] They are also used by rubber manufacturers. Yellow shales after grinding have been utilized in the manufacture of paint. Their principal use, however, is in the manufacture of oilcloth and linoleum. The red shales find their principal use as a pigment in the cheaper grades of paint, used primarily for outbuildings and barns.

9/ Thorpe, Edward, A Dictionary of Applied Chemistry: Vol. 5, London, 1924, p. 48.

10/ Toch, Maximilian, Chemistry and Technology of Mixed Paints: New York, 1907, p. 41.

11/ U. S. Geological Survey, Mineral Paints: Mineral Resources of the United States, Part I, 1914, pp. 111-12.

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SUBSTITUTES

The iron oxide pigments as a class are the cheapest pigments in their respective fields and hence tend to be substituted for other pigments rather than to be displaced themselves. In the iron oxide group itself, however, the artificial oxides tend to replace the natural pigments. Rapid progress has been made by color manufacturers in the perfection of these chemically prepared pigments and as prices have been lowered, many users who formerly purchased the natural-mined pigments now prefer the chemically-prepared pigments. By admixture of the various pure ferric oxide pigments now on the market with inert fillers, most of the natural pigments can be duplicated, often with considerable saving in cost. The carbon blacks, both mineral and organic, have generally proved superior for certain uses to black iron oxides.

Mortar colors and ground slate and shale have no substitutes in the sense of similar cheaper products, as they constitute in themselves the cheapest of the mineral pigments.

SOURCES OF SUPPLY

Natural

Iron is the fourth most abundant material comprising 5.06 per cent of the lithosphere.12/ It is found in greater or lesser amounts in practically all rocks. The mineral species of which iron is a normal constituent are numbered by the hundreds. Among the most important may be mentioned magnetite, hematite, limonite, pyrite, marcasite, pyrrhotite, and siderite. The first two are oxides; limonite is the hydroxide; pyrite, marcasite and pyrrhotite are sulphides; and siderite is the carbonate.

Only hematite and limonite, however, are extensively employed as pigments.

Magnetite or magnetic iron ore (Fe_3O_4 or $FeOFe_2O_3$) deposits of economic importance occur in Warren, Essex, and Clinton Counties in northern New York. Other important deposits in the East are in New Jersey and in the vicinity of Cornwall, Pa. In the West, numerous deposits are found in California and in Colorado, New Mexico, and Arizona.

Hematite or specular iron ore (Fe_2O_3) occurs as Clinton hematite or red hematite in Tennessee and Alabama and accounts for the larger part of the red iron oxide pigments produced in the United States. The columnar and earthy varieties of hematite are found in enormous beds that furnish a large proportion of the iron ore requirements of the world. The important deposits in the United States are around the southern and northwestern shores of Lake Superior in Michigan, Wisconsin, and Minnesota. Hematite is found at Iron Mountain and Pilot Knob in southeastern Missouri. Deposits of considerable importance are located in Laramie and Carbon Counties in Wyoming. Deposits of hematite suitable for use as iron ore are not necessarily suitable for use as paint pigment, as the color may have no commercial value.

12/ Clarke, F. W., Data of Geochemistry: Bull. 770, U. S. Geol. Survey, 1924, p. 36.

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Limonite or bog iron ore ($2Fe_2O_3.3H_2O$) deposits are quite numerous throughout the United States. Many of them, however, contain considerable impurities which detract greatly from their economic value. Fairly pure limonite derived from iron-bearing limestones often is of commercial value and such deposits are found along the Appalachian Mountains from western Massachusetts southward into Alabama. Limonite deposits of various kinds are found throughout the Western States, but as yet they have not been extensively developed.

Siderite or spathic iron ($FeCO_3$) in its crystallized form is a common vein mineral associated with various metallic ores, such as silver minerals, pyrite, galena, etc. The ironstone form of siderite is abundant in coal measures in certain coal districts of the United States. Pennsylvania produces practically all the gray siderite for pigment purposes from a deposit near Lehigh Gap.13/

Pyrrhotite or mundic (magnetic pyrites) was formerly a fairly important source of copperas and has been used from time to time as a source of iron oxide pigments.

In the United States another possible source of iron oxide pigments is the mine water from coal mines. Water from the coal mines of western Pennsylvania for instance carries considerable iron oxide in suspension, and in a number of places is dammed and the iron allowed to settle.

Artificial or Prepared

Pickling liquors and various metallurgical wastes contain ferrous sulphate in solution, and these liquors are an important source of iron oxide pigments. Scrap steel, chiefly No. 2 scrap or clippings, is used, especially for yellow pigments. Several other materials are also used in the manufacture of iron paints. Iron blast furnace dust, a grayish brown powder, consisting mainly of iron oxide and coke, is sometimes ground to produce a seal-brown pigment.

Hematite and limonite and other brown iron ores which do not have a pleasing color are calcined to produce the desired color, while others are fortified or strengthened by the addition of some coal-tar dyes such as alizarine lake.

Pyrite cinder or "blue-billy," the residue resulting from burning pyrite (or pyrrhotite) in sulphuric acid manufacture, is used as a mortar color and for abrasive and polishing purposes.

MINING AND PREPARATION

The mining of naturally-occurring iron oxide pigment whether carried on in open-cuts or underground affords no unusual features. The preparation of these pigments from the ores likewise is relatively simple and inexpensive. Often the ore is simply ground in its natural state or after calcining.

13/ U. S. Tariff Commission, Work cited, p. 91.

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To reclaim iron oxide from mine waters, ground limestone or lime may be fed to the raw water, using a baffled flume to mix the lime well and permitting the water to flow into tanks or settling basins of sufficient capacity to retain the water for four or five hours. During this time the hydrated oxides of iron will settle out as a fairly thick sludge. This sludge, however, is too thin to shovel and too thick to pump. One company runs the sludge from the thickener to a settling tank, and then finally sprays it on a revolving iron drum. This drum is heated and the dried film of oxide is scraped off. The yellow powder is bagged and shipped to pigment plants for further treatment.[14] This plant has not been in operation for several years.

The paint ores of the Lehigh Gap district, Pennsylvania, consisting of a mixture of siderite (iron carbonate) with some pyrite (iron sulphide), occur in narrow veins, usually not over 2 1/2 feet wide.[15] These veins are worked by simple underground mining methods from tunnels or shafts. The ore is shot down, sorted from the waste, and trammed to the mill, where it is first calcined in vertical kilns, resembling limekilns, about 10 feet in diameter and 25 feet high. Wood is used as a fuel, burned in fire boxes at the base of the kiln. The calcined ore, of a dark reddish brown color, is crushed in gyratory crushers, ground fine in horizontal or vertical buhr mills, and packed, chiefly in 300 to 500 pound barrels.

The artificial or chemically produced ferric oxide pigments are a relatively new development. The manufacture of yellow iron oxide pigments is described by Berling[16] as follows:

> The iron solution is subjected to the action of an oxidizing agent, and a reaction occurs in which the iron solution is both reduced by the metallic iron and oxidized by the oxidizing agent, which results in hydrated ferric oxide. This is removed then from the solution tanks by filtration, thoroughly washed to remove all traces of acidity, dried and ground.

According to the same authority there are three general methods of manufacturing the artificial red oxides, as follows: (1) Heating copperas (ferrous sulphate) in retorts or kilns; (2) heating a mixture of lime and copperas; and (3) heating a yellow oxide.

> Most of the present red oxides and Indian red oxides are manufactured by the first method, which, briefly, consists of heating the copperas until the sulphur trioxide is driven off and the iron oxidized. The sulphur trioxide must be either recovered, or disposed of so as not to be a nuisance. In this process, the light or Turkey red shades are made at the lower temperatures, and the darker shades,

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14/ Leitch, R. D., Observations on Acid Mine Drainage in Western Pennsylvania: Bureau of Mines, Report of Investigations 2889, Sept., 1928, 18 pp.
15/ Ladoo, R. B., Work cited, pp. 384-5.
16/ Berling, F. C., Oxide of Iron Pigments: Canadian Chem. and Met., vol. 15, Jan., 1931, pp. 16-18.

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ranging from a medium red to a dark purple Indian red, are made at the higher temperatures. After being taken from the furnace the products are graded carefully and then ground and washed by levigation to free the product from the unburned remnants of copperas.

The so-called Venetian red colors usually are made by the second method, and the ferric oxide content of these varies from 10 to 40 per cent. The low ferric oxide content is due to the presence of calcium sulphate, which is formed by the reaction of the lime and copperas. This group of pigments forms a very complete and useful type because, due to chemical control, a very wide range of shades, ranging from light shades of red with yellow tints to dark shades of red with blue tints, is possible.

The third process of making red oxides from heating a yellow oxide is an adaptation or a continuation of the artificial yellow oxide process mentioned above, and any variation of shade from a clear light bright red oxide to a deep purple shade of Indian red can be produced by this method.

The properties of these artificial yellow and red oxides are that they are perfectly permanent and have excellent coloring power and body. They are free from acidity and alkalinity, and if they are pure ferric oxides, are, of course, quite insoluble in water. Most of the artificial yellow oxides sold at present have a small water soluble content, and manufacturers are endeavoring to eliminate this feature through improvement in process and equipment.

PRODUCTION

The United States is the largest consumer of iron oxide paints in the world, and most of its requirements are supplied from domestic sources.

While accurate statistics as to production of iron oxide pigments are not available because of the diversity of products and the difficulty of correct classification, Tables 1, 2, and 3 will give some idea of the growth of the domestic industry since 1914. The figures in these tables are taken from different sources and do not include the same products over a period of years.

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Table 1. - Iron ore sold for paint, by producers in the United States, 1918-1930 1/

Year	Short tons	Value	Year	Short tons	Value
1918	10,034	$ 22,924	1924	23,106	$ 103,626
1919	17,885	84,630	1925	29,704	140,986
1920	27,382	112,364	1926	23,707	129,541
1921	11,624	56,824	1927	25,815	132,007
1922	30,668	166,682	1928	17,815	83,190
1923	27,823	140,306	1929	15,754	90,352
			1930	10,832	53,520

1/ Mineral Resources of the United States, Part I, Summary (Annual).

Table 2. - Domestic natural mineral pigments 1/ sold in the United States, 1909-1916 2/

Year	Short tons	Value	Year	Short tons	Value
1909	60,220	$ 567,028	1913	70,595	$ 512,410
1910	68,623	527,795	1914	66,766	633,390
1911	62,739	498,821	1915	57,442	551,598
1912	74,657	561,693	1916	(3)	(3)

1/ Include ocher, umber, sienna, metallic paint mortar colors, and ground slate and shale.
2/ Mineral Resources of the United States, U. S. Geol. Survey, Part I, 1919, p. 86a.
3/ Canvass discontinued after 1915.

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Table 3.- Iron oxides and other mineral pigments produced for sale in the United States by States (short tons), 1914-1929 1/

	1914		1919		1921		1923	
	Tons	Value	Tons	Value	Tons	Value	Tons	Value
Iron oxides, total	46,448	$ 797,819	101,091	$ 3,778,942	42,564	$1,951,887	63,545	$3,133,953
Natural (ocher, sienna, umber, etc.), total	2/46,448	2/797,819	2/101,091	2/3,778,942	41,379	1,737,478	61,000	2,718,088
Pennsylvania	14,396	199,576	62,373	2,433,231	17,237	549,061	11,799	472,979
New York	(3).	(3)	9,595	425,966	7,019	274,889	(3)	(3)
Other States	32,053	598,243	29,122	919,745	21,123	913,528	49,201	2,245,109
Synthetic precipitated, total	(4)	(4)	(4)	(4)	1,185	214,409	2,454	415,863
Other mineral colors, total	(5)	(5)	19,132	1,176,505	25,919	709,939	72,445	2,349,088
Pennsylvania	-	-	-	-	-	-	46,330	1,895,433
New York	-	-	-	-	-	-	(3)	(3)
Other States	-	-	-	-	-	-	26,115	463,649

	1925		1927		1929	
	Tons	Value	Tons	Value	Tons	Value
Iron oxides, total	44,386	$2,381,148	54,179	$3,357,895	22,814	$ 3,374,800
Natural (ocher, sienna, umber, etc.), total	39,023	1,517,997	48,338	2,452,134	2/22,814	2/3,374,800
Pennsylvania	-	-	-	-	17,456	1,170,345
New York	-	-	-	-	(3)	(3)
Other States	-	-	-	-	35,358	2,204,455
Synthetic precipitated, total	5,563	866,151	5,842	905,761	(4)	(4)
Other mineral colors, total	20,554	858,307	14,600	343,884	8,632	254,373
Pennsylvania	17,180	568,458	-	-	4,305	137,790
New York	724	160,604	-	-	(3)	(3)
Other States	2,644	129,245	-	-	4,327	116,525

1 Biennial census of manufacturers, Census Bureau, Department of Commerce.
2 Includes data for synthetic iron oxide.
3 Included in figures for "Other States."
4 Included in figures for "Natural" iron oxide.
5 No data.

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IMPORTS

Notwithstanding the considerable domestic production and export trade in iron oxide pigments, the American paint and other consuming industries purchase substantial quantities of certain high-grade natural pigments abroad.

Tables 4, 5, and 6 show the general imports and imports for consumption of mineral earth pigments into the United States for the years 1923 to 1930, inclusive. Under the classification "iron oxide and iron hydroxide pigments," the general imports into the United States have shown a slight decrease, amounting to only some 17 million pounds, valued at $375,176, in 1930 as compared with 24 million to nearly 28 million pounds for the years 1926 to 1929, inclusive. The value during these four years ranged from about $587,000 to over $666,000. Spain is by far the largest source of pigments under this classification, furnishing on the average about 33 per cent. The amount imported from Spain in 1930 was only about 10 million pounds as compared with 14 to 19 million pounds in the four previous years.

Table 4 shows the imports of "other mineral earth pigments, other than ocher and sienna" for the years 1923 to 1925, after which years the classification was changed. Under this heading Belgium was the largest foreign source, furnishing the United States about 30 per cent of the total quantity imported. Other countries furnishing fairly large quantities were France, Spain, Germany, and the United Kingdom.

Table 6 shows the total imports for consumption of mineral earth pigments (iron oxide and iron hydroxide) into the United States for the years 1923 to 1930, inclusive.

The United Kingdom is also one of the principal sources for iron oxide pigments. During the past few years this country has shipped annually to the American market approximately 25 per cent of its total output or 2,500 short tons, of a total production of about 10,000 tons. A considerable portion of this, however, is Spanish ore, ground and prepared in English mills.

Canada, with an annual production of approximately 6,500 short tons, exports to the United States about 1,000 tons annually or 15 per cent of its total output.

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Table 4. - Imports for consumption of other mineral earth pigments, other than ocher and sienna, into the United States 1/

Imported from:	1923		1924		1925	
	Pounds	Value	Pounds	Value	Pounds	Value
Austria	21,164	$ 280	3,254	$ 69	---	---
Belgium	24,216,092	77,122	21,311,103	67,302	24,193,097	80,432
Czechoslovakia	22,528	458	57,290	823	132,168	1,497
Denmark	3,277,185	16,626	6,017,497	25,816	4,614,202	25,286
France	17,969,578	58,218	15,981,984	53,664	17,697,764	58,899
Germany	2,220,659	44,599	1,323,354	27,556	1,291,785	26,023
Italy	1,752,907	25,476	480,113	13,396	491,474	13,074
Malta, Gozo, and Cyprus	5,368,668	40,075	6,507,027	50,692	4,419,573	34,445
Netherlands	65,695	5,361	62,406	995	7,063	676
Norway	358,495	27,012	11,570	727	---	---
Spain	12,163,567	242,643	15,509,524	255,148	17,175,071	263,702
Sweden	10,956	45	1,710	183	67,115	319
England	7,899,231	393,595	7,402,922	299,458	8,707,283	379,002
Scotland	112,047	5,467	7,044	234	(2)	(2)
Ireland	610,798	1,133	---	---	(2)	(2)
Canada	2,137,900	53,412	1,566,741	37,558	1,717,299	38,236
Cuba	220	66	---	---	226	30
China	---	---	---	---	600	10
India	---	---	---	---	---	---
Japan	22	6	418,510	1,588	---	---
Egypt	---	---	---	---	1,238,013	7,713
Australia	---	---	100	9	---	---
Port East Africa	---	---	---	---	838,278	5,477
Palestine and Syria	451,428	3,166	---	---	---	---
Greece	---	---	---	---	---	---
Switzerland	---	---	---	---	---	---
Other countries	---	---	---	---	---	---
Total	78,659,740	994,760	76,662,149	835,218	82,591,011	934,821

1/ Foreign Commerce and Navigation of the United States, Department of Commerce (Annual).

2/ Included under England after 1923.

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Table 5.- General imports of mineral earth pigments (iron oxide and iron hydroxide) into the United States[1]/

Imported from	1926		1927		1928		1929		1930	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Germany	482,623	$11,056	663,758	$18,899	1,200,289	$31,947	1,255,617	$72,927	1,157,788	$38,271
Spain	19,140,028	306,133	14,781,426	272,164	14,210,905	249,528	13,723,646	216,326	10,066,309	138,721
United Kingdom	6,582,290	313,475	5,047,680	231,642	5,677,687	246,577	5,381,828	236,353	3,466,263	147,449
Canada	1,551,030	32,847	1,718,685	35,212	2,268,977	43,352	2,263,412	43,503	1,124,800	33,866
Belgium	-	-	14,696	562	-	-	86,207	1,585	-	-
France	-	-	1,766,146	27,778	2,121,242	35,502	1,725,631	28,222	1,223,322	16,869
Italy	-	-	1,541	95	9,693	340	-	-	-	-
Switzerland	-	-	55,555	1,187	-	-	-	-	-	-
Other countries	231,072	3,332	840	95	2,696	106	4,584	241	-	-
Total	27,987,043	666,843	24,050,327	587,634	25,401,489	607,352	24,440,925	599,157	17,038,482	375,176

1 Foreign Commerce and Navigation of the United States, Department of Commerce (Annual).

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Table 6. - Imports for consumption of mineral earth pigments (iron oxide and iron hydroxide) into the United States 1/

Year	Pounds	Value
1923	21,326,790	$ 674,812
1924	24,591,032	582,939
1925	26,978,925	668,170
1926	27,985,923	666,766
1927	24,038,987	586,883
1928	25,456,096	604,895
1929	24,343,077	593,291
1930	17,002,130	373,453

1/ Foreign Commerce and Navigation of the United States, Department of Commerce (Annual).

TARIFF HISTORY

Prior to the Tariff Act of 1913, iron oxide pigments, both natural and artificial were dutiable under general provisions for "pigments, not elsewhere provided for." Under the acts of 1883 and 1890 and again under the 1894 act the duty under this bracket remained at 25 per cent ad valorem. Subsequently, under the acts of 1897 and 1909 it was raised to 30 per cent ad valorem. The act of 1913 (par. 55) introduced a new provision for "Spanish brown, venetian red, Indian red, and colcothar or oxide of iron, not specially provided for" and reduced the rate of duty to 10 per cent.

Under the acts of 1922 (par. 75) and 1930 (par. 73) pigments classified "under oxide, and iron hydroxide pigments, not specially provided for" was dutiable at 20 per cent ad valorem.

EXPORTS

The United States is the world's largest exporter of mineral pigments.

The quantity of iron oxide pigments exported from the United States has been growing steadily during the past few years, amounting in 1930 to 45,132,189 pounds, valued at $535,193. This represents an increase of 7 per cent in quantity over the preceding year but a decrease of 38 per cent in value. The low unit price of iron oxide pigments as compared with their bulk handicaps considerably the development of a larger export trade with distant markets. This, however, is partly overcome by the high favor enjoyed by American pigments, due to their uniformity of color and fine texture.

Slackened building activity in many world markets during 1930, a consequently smaller consumption of paint, and only a slight retrenchment in mineral earth pigment production both in the United States and foreign countries,

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Table 7.- Exports of mineral earth pigments, ocher, umber, sienna, and other forms of iron oxides for paints by the United States by countries, 1923-1930 1/

	1923		1924		1925		1926		1927		1928		1929		1930	
	Quantity (pounds)	Value (dollars)	Quantity (pounds)	Value (dollars)	Quantity (pounds)	Value (dollars)	Quantity (pounds)	Value (dollars)	Quantity (pounds)	Value (dollars)	Quantity (pounds)	Value (dollars)	Quantity (pounds)	Value (dollars)	Quantity (pounds)	Value (dollars)
Belgium	100,036	$ 1,726	726	$ 121	3,522	$ 507	10,279	$ 1,899	52,979	$ 5,692	129,418	$ 8,596	60,506	$ 2,806	261,794	$ 6,108
Denmark	---	---	400	60	36,586	5,758	8,225	863	31,183	4,598	39,680	1,066	30,746	1,306	3,000	230
France	258,831	4,532	336,110	6,578	360,360	10,099	560,532	27,038	485,807	26,017	580,146	18,949	203,498	4,156	327,726	8,880
Germany	---	---	611,415	13,604	216,922	5,687	266,133	11,077	580,494	20,598	707,040	24,484	684,699	28,408	233,063	13,563
Italy	358,087	8,886	583,822	10,014	567,443	9,278	216,544	3,823	131,718	4,684	200,096	6,250	113,421	4,098	144,836	5,646
Latvia	44,800	882	89,507	1,676	48,165	845	---	---	44,697	949	47,269	1,096	93,684	2,146	46,822	1,060
Netherlands	1,014,719	14,904	1,109,665	19,625	1,064,777	19,729	1,131,656	25,008	1,084,450	25,370	1,823,915	37,997	548,004	12,816	237,565	9,508
Russia in Europe	1,250	21	25,445	922	89,363	1,673	44,960	862	1,093,823	17,004	141,145	3,278	---	---	7,020	246
Spain	129,968	3,254	4,397	884	5,414	711	53,761	2,687	25,583	2,410	300	34	---	---	---	---
Sweden	---	---	---	---	14,300	2,065	23,494	2,225	55,152	4,671	1,170	28	2,515	225	34,170	2,817
England	1,312,116	26,527	1,497,732	33,639	7,591,228	114,666	6,070,708	119,246	6,285,334	108,877	7,177,980	113,000	7,527,173	255,748	5,485,965	104,551
Scotland	3,850,627	52,258	6,210,761	85,512	2/	2/	2/	2/	2/	2/	2/	2/	2/	2/	2/	2/
Canada	11,685,145	302,265	9,808,826	220,254	13,047,301	303,588	14,860,025	362,874	17,130,319	427,382	16,964,975	341,147	24,800,591	332,714	32,945,870	245,985
Costa Rica	23,744	1,401	29,528	1,682	43,293	1,673	23,381	801	44,139	2,596	18,391	1,137	12,622	612	9,484	397
Guatemala	16,076	1,116	84,056	1,895	30,357	1,886	40,345	2,583	68,397	4,658	29,099	1,516	15,772	621	18,401	982
Honduras	15,619	1,641	9,349	923	18,779	1,471	37,152	2,802	21,603	1,456	6,456	548	7,246	588	5,657	418
Nicaragua	13,806	1,509	25,221	1,925	16,566	1,006	12,869	701	37,141	2,069	30,755	1,594	7,669	444	11,421	299
Panama	92,236	6,575	123,501	5,382	84,276	5,846	156,686	6,544	250,473	9,285	129,020	5,794	263,156	4,439	175,393	8,254
Salvador	38,365	3,287	26,623	2,568	28,777	2,396	37,358	2,877	12,946	800	17,510	876	6,149	278	3,226	190
Mexico	447,829	38,345	481,723	27,614	610,503	34,575	398,089	22,212	1,250,088	43,132	1,298,552	36,715	635,940	19,136	292,875	10,922
Newfoundland	136,743	3,897	135,480	5,546	293,574	7,015	338,904	7,113	339,436	6,686	259,758	5,542	328,750	5,340	391,690	4,232
Bermuda	10,792	1,360	2,779	190	10,963	574	4,362	166	10,502	433	5,577	701	719	28	688	28
Cuba	1,480,677	93,201	965,573	51,458	817,715	38,674	644,050	31,939	701,509	31,937	525,690	24,709	2,187,046	23,057	217,614	5,357
Dominican Republic	118,653	8,413	133,369	6,310	187,515	7,923	151,394	5,794	233,164	9,482	191,962	7,136	70,797	3,021	37,942	2,015
Haiti	107,202	4,736	104,856	4,536	87,434	4,207	70,538	2,676	111,424	6,505	55,912	2,150	33,700	1,181	24,009	1,171
Virgin Islands	12,156	657	6,375	290	8,517	257	11,407	459	8,482	301	8,245	322	9,670	281	5,058	111
Argentina	46,695	8,445	78,557	7,678	64,354	7,799	56,878	6,060	137,646	15,651	177,690	7,008	138,123	9,120	116,247	17,956
Bolivia	3,000	351	1,132	120	1,150	177	1,854	286	2,860	168	6,300	374	1,800	130	2,900	406
Brazil	19,610	1,640	5,504	434	30,241	2,877	24,291	2,948	25,934	4,220	29,245	2,648	35,163	2,217	12,594	864
Chile	147,409	10,895	66,437	5,468	52,960	3,345	139,889	7,452	54,795	3,491	54,900	2,618	5,520	345	40,838	7,615
Colombia	163,576	14,825	105,770	9,256	164,616	12,059	279,406	18,564	201,566	12,747	322,139	17,096	193,696	6,439	85,567	6,031
Ecuador	16,498	1,115	17,716	1,493	7,289	755	23,296	1,001	20,193	1,125	3,000	81	17,500	200	2,400	138
Peru	47,600	5,653	48,737	3,894	24,048	1,534	56,736	4,305	174,633	5,262	351,589	6,454	9,434	261	15,785	304
Uruguay	13,597	1,250	10,867	570	34,140	2,001	12,633	1,219	17,262	1,827	3,520	256	9,789	677	10,800	1,793
Venezuela	190,795	12,160	154,468	9,399	199,261	8,905	156,324	16,746	295,843	11,519	263,431	11,505	326,450	6,980	477,800	11,567
British India	156,887	7,012	55,340	976	12,206	1,135	11,115	854	80,429	4,059	25,927	1,229	4,410	282	---	---
China	190,476	11,750	140,474	10,067	66,598	7,342	61,442	4,042	40,953	3,925	73,799	3,571	18,084	1,451	5,840	722
Japan	1,111,863	51,115	852,803	28,555	805,542	28,405	584,515	23,083	570,638	21,156	1,080,787	31,735	1,063,437	28,752	485,618	14,932
Philippine Islands	329,219	27,456	313,006	19,228	264,687	15,169	525,414	34,273	493,119	31,032	344,367	14,425	78,600	6,262	55,015	3,734
Australia	1,855,159	110,274	1,372,901	72,990	1,072,760	58,427	1,384,564	72,032	1,092,893	63,507	2,035,103	87,524	981,807	35,696	194,929	2,527
New Zealand	321,323	18,405	260,082	12,923	204,337	11,267	282,730	12,736	424,966	21,201	157,152	7,737	68,158	3,483	4,365	285
All other countries	2,721,352	144,406	2,477,471	137,440	2,971,934	160,534	3,180,934	171,793	3,349,809	169,615	3,403,040	246,929	1,454,081	58,833	2,704,254	36,541
Total	28,554,484	999,177	28,206,731	825,563	31,264,521	902,833	31,954,847	1,006,181	37,292,451	1,125,030	39,733,021	1,093,820	41,959,784	862,570	45,132,189	535,195

1/ Commerce and Navigation of the United States (Annual), Department of Commerce.
2/ Included under England as the United Kingdom.

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have resulted in cautious purchasing and price cutting to move existing pigment stocks.17/

Canada is the outstanding export outlet for American iron oxide pigments, taking annually 40 to 45 per cent of the total exports, an amount equal to about three times the Canadian production, which is valued at approximately $116,000 annually. As may be noted in Table 7, quantity exports of mineral earth pigments to Canada showed a substantial gain in 1930. The ever-widening use of iron oxide pigments in paints in the United Kingdom places that country in second rank as a market for American iron oxide pigments.

Shipments to former major markets, such as the Union of South Africa, Australia, Japan, Germany, and Cuba, declined materially both in quantity and value during 1930. The trade with France and Belgium, although relatively small, increased in both quantity and value during the past year.

MARKETING AND PRICES

The United States is the largest consumer of iron oxide pigments in the world and its requirements are furnished by both domestic and foreign producers. Domestic mineral pigments usually are either mined by some of the larger consumers, or marketed by the producers directly to the consumers.18/ There are only a few large producers in this country and they in a certain degree control the market for domestic mineral pigments. These producers usually handle a wide variety of natural colors and have built up reputations for uniformity and high grade of product. Many large customers prefer to deal only with such companies rather than to buy each color from a different small producer. Some of the smaller producers market their product through brokers or jobbers.

Imported pigments are handled by all the big color manufacturers, but some consumers import part of their pigments directly.

The following tabulation price quotations, Table 8, was taken from the special review number of the Oil, Paint, and Drug Reporter for the years involved. The prices are for carload lots in the New York market, unless otherwise noted.

17/ Wood, E. C., and Kiefer, E. A., United States Foreign Trade in Mineral Earth Pigments: Chemical Division, Commerce Reports, May 18, 1931, p. 419.

18/ Ladoo, R. B., Work cited, p. 387.

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Table 8. - Prices of iron oxide pigments, cents per pound 1/

	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
Oxide, red, copperas:											
High	19	14	14	14	12	4	4	4	4	4	4
Low	10	10	10	4	4	4	4	4	4	4	4
Tuscany red:											
High	44	44	35	25	25	15	15	15	15	15	15
Low	17½	17½	17½	15	15	15	15	15	15	15	15
Venetian red:											
High	9	6½	6	6	5	1½	1½	1½	1½	1½	1½
Low	3½	3½	3½	1½	1½	1½	1½	1½	1½	1½	1½
Indian red, Amer. pure:											
High	16½	12	12	15	15	10	10	10	10	10	10
Low	8	8	8	8	10	10	10	10	10	10	9¾
Iron oxide, black:											
High	20	16	16	16	18	4½	4½	4½	4½	4½	4½
Low	4½	4½	4½	4	4	4	4½	4½	4½	4½	4½

1/ Oil, Paint and Drug Reporter (Weekly).

FOREIGN COUNTRIES

Spain 19/

Spain is one of the most important producers of natural red oxide of iron for use in the manufacture of paints. The principal deposits are in eastern Andalusia in the interior Province of Jaen, where it is produced partly as a by-product in mining iron ore, with which it occurs. The iron oxide occurring in this Province is a variety of red hematite containing between 80 and 90 per cent of ferric oxide and is the standard grade of "Spanish red oxide," with extreme brilliancy and covering power.

In 1929, in the Province of Jaen, there were two plants in operation for the grinding of red oxide of iron: the Fabrica de Villargardo, owned by the Sociedad Espanola de Oxidos y Pinturas, and the Santa Daria mill, the property of the Sociedad Oxidos Florez.

The plant situated near the railroad station of Villargardo (on the line of the Puenta Genil-Linares railroad) consists of two ball mills having capacities of 1,200 and 800 kilograms, respectively. A fairly fine product is obtained, 99 per cent passing 5,000 mesh to the square centimeter (approximately 175 mesh). The hematite treated at this plant comes from the company's mines in the district of Torrequeleradilla, in the same Province, distant about 14 kilometers from the plant. Hauling is made under contract by mules and wagons.

19/ Estadistica Minera de Espana, Madrid, Spain (Annual). (Translation by E. P. Youngman.)

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The Santa Daria plant is located near the railroad station at Jaen. The mines of the Sociedad Oxidos Florez are in the district of Torredelcampo, Province of Jaen, 22 kilometers from the grinding plant. Transportation is partly by mule-drawn wagons and by rail over the Puenta Genil-Linares line. Wet-grinding in French buhr mills produces a paste, which after filtering passes to the calcining furnaces and afterwards to disintegrating mills.

The entire production from these two plants is exported through the port of Malaga.

In the Province of Malaga there were five active plants engaged in grinding and preparing iron oxide for use in the paint industry in 1929.

The following is a list of the names of the 13 grinding plants in operation in Spain in 1929.

Iron oxide grinding plants in operation in Spain in 1929

Province	Plant
Jaen	Fabrica de Villargardo
	Santa Daria
Malaga	La Albion
	La Helvetia
	La Perseverancia
	Santa Elena
	La Victoria
Guipuzcoa	
Guadalajara	Santa Engracia
Alicante	Las de Villafranqueza
	San Vincente del Raspeig
Zaragoza	La Compania Aragonesa

Table 9 shows the production of ground iron oxide for pigment purposes in Spain by Provinces for the years 1924 to 1929, inclusive:

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I.C. 8627 Table 9.- Production of ocher and crude iron oxide by provinces in Spain[1/]

Provinces	1924 Hematite used, metric tons	1924 Iron oxide produced, kilograms	1924 Value, pesetas	1925 Hematite used metric tons	1925 Iron oxide produced, kilograms	1925 Value, pesetas	1926 Hematite used metric tons	1926 Iron oxide produced, kilograms	1926 Value, pesetas
Alicante	---	---	---	---	---	---	1,100	1,055,000	158,250
Guadalajara	50	48,000	1,200	40	38,000	950	50	48,000	1,200
Guipuzcoa	---	---	---	---	---	---	---	---	---
Jaen	12,289	11,350,000	1,560,625	7,775	7,000,000	962,500	4,285	3,630,870	512,751
Malaga	14,450	13,994,000	3,736,000	10,950	10,424,000	2,783,208	15,006	14,870,000	3,739,170
Zaragoza	220	210,000	48,300	200	190,000	43,700	200	190,000	43,700
Sevilla	520	500,000	100,000	535	500,000	100,000	---	---	---
Total		26,102,000	5,446,125		18,152,000	3,890,358		19,793,870	4,455,071
Grinding plants in operation		11			9			12	

Provinces	1927 Hematite used metric tons	1927 Iron oxide produced, kilograms	1927 Value, pesetas	1928 Hematite used metric tons	1928 Iron oxide produced, kilograms	1928 Value, pesetas	1929 Hematite used metric tons	1929 Iron oxide produced, kilograms	1929 Value, pesetas
Alicanta	1,680	1,520,000	152,000	1,890	1,838,000	188,800	962	960,000	144,000
Guadalajara	45	40,000	1,200	45	40,000	1,200	50	45,000	4,500
Guipuzcoa	---	---	---	233	230,940	36,950	182	180,000	28,800
Jaen	4,875	4,235,932	598,205	3,048	3,046,100	570,918	4,260	4,085,250	772,787
Malaga	13,294	13,068,000	3,361,960	14,260	13,540,000	3,406,000	14,380	13,106,000	3,282,460
Zaragoza	140	133,000	15,960	270	256,000	30,720	130	122,000	122,000
Sevilla	---	---	---	---	---	---	---	---	---
Total		18,996,982	4,129,325		19,001,040	4,236,588		18,498,250	4,244,747
Grinding plants in operation		12			13			13	

1/ Estadistica Minera de Espana, Madrid (Annual).

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Exports

Detailed statistics with reference to total exports of iron oxide for pigment purposes from Spain are not available.

The Port of Malaga is the chief center of both the preparation and export of crude and refined iron oxide for pigment and filler purposes. According to American consular officers in Malaga the exports of red oxide of iron from that port increased steadily in the period, 1926-1929, totaling 31,076 metric tons in 1929; 29,976 tons in 1928; 28,852 tons in 1927; and 28,435 tons in 1926.[20] The Spanish crude red oxide comprising about 40 to 45 per cent of the total trade for pigment purposes is shipped principally to Germany, France, Belgium, Italy, United States and Great Britain. The ground product finds an outlet in about 25 foreign countries. The United States is the principal market, taking 35 to 40 per cent of the Malaga exports of refined Spanish red oxide of iron annually and only 8 to 10 per cent of the crude hematite earth.[21] Other leading purchasers are Great Britain, Argentina, the Netherlands, Germany, Australia, Italy, Belgium, and France.

Tables 10 and 11 show the exports of ocher and other earth pigments (excluding iron oxide) unground (1926-1929) and ground (1927-1929), respectively. Exports of iron oxide for pigment purposes are grouped with iron ore shipments and are not shown separately.

Table 10. - Ochers and other earth pigments, not ground, exported from Spain 1/

	1926		1927		1928		1929	
	Metric tons	Value, pesetas	Metric tons	Value, pesetas	Metric tons	Value, pesetas	Metric tons	Value, pesetas
Germany	---	---	6	720	---	---	26	2,080
Algeria	---	---	---	---	---	---	20	1,600
Argentina	46	8,352	---	---	---	---	21	1,640
France	226	40,608	44	5,244	27	3,180	291	23,280
Great Britain	686	123,552	586	70,320	437	52,440	68	5,440
Holland	124	22,230	---	---	---	---	---	---
Italy	87	15,588	---	---	---	---	3	224
Cuba	92	16,506	21	2,532	---	---	---	---
United States	92	16,560	---	---	---	---	---	---
Other countries	213	38,438	5	612	2	216	---	---
Total	1,566	281,834	662	79,428	465	55,836	428	34,264

1/ Estadistica del Comercio Exterior de Espana, Madrid (Anmual).

20/ Wood, E. C., and Kiefer, E. A., United States Foreign Trade in Mineral Earth Pigments: Dept. of Commerce, Commerce Reports, May 18, 1931.
21/ Wood, E. C., and Kiefer, E. A., Work cited.

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Table 11. - Ocher and other earth pigments, ground, exported from Spain 1/

	1927		1928		1929	
	Metric tons	Value, pesetas	Metric tons	Value, pesetas	Metric tons	Value, pesetas
Centa	2	285	---	---	3	748
Metilla	2/	30	---	---	1	220
Germany	---	---	2	330	5	1,144
Argentina	680	101,970	344	51,600	525	115,522
Belgium	7	1,020	---	---	5	1,100
United States	109	16,335	429	64,275	385	84,744
France	40	5,970	19	2,910	13	2,838
Great Britain	149	22,395	146	21,960	151	33,242
Holland	29	4,380	37	5,505	69	15,180
Italy	24	3,630	56	8,430	3	5,544
Uruguay	34	5,040	58	8,760	73	16,082
Other countries	54	8,160	28	4,230	---	---
Total	1,128	169,215	1,120	168,000	1,256	276,364

1/ Estadistica del Comercio Exterior de Espana, Madrid (Annual).
2/ Less than 1 ton.

Great Britain

Great Britain is also an important source of iron oxide pigments, producing annually approximately 10,000 tons and exporting not only a portion of the domestic production but also quantities of red oxide of iron of Spanish origin, imported in the crude state and prepared for market in British grinding mills.22/

The principal iron oxide mining districts in England are in the counties of Somerset and Gloucester. During 1930, these two counties accounted for approximately 80 per cent of the total output as follows: Somerset, 4,161 long tons and Gloucester, 2,704 tons.

Table 12 shows the output of ocher, umber, and other iron oxide pigments for the years 1919 to 1930, inclusive.

22/ Wood, E. C., and Kiefer, E. A., Work cited.

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Table 12. - Production of ocher and umber 1/ in Great Britain 2/

Year	Long tons
1919	10,547
1920	15,537
1921	10,310
1922	9,036
1923	10,293
1924	10,469
1925	11,224
1926	10,203
1927	10,464
1928	10,504
1929	9,343
1930	8,623

1/ Includes micaceous iron ore, ferric oxide, and similar minerals.
2/ Annual Report, Chief Inspector of Mines, Secretary of Mines, London (Annual).

Imports and Exports

Great Britain has a considerable foreign trade in natural pigments, as may be seen from the following Tables 13, 14, and 15, which show the quantity and value of the imports and exports of ocher and earth colors for the years 1925 to 1930.

Due to world conditions, exports of natural pigments from Great Britain have shown some falling off during the past two or three years. The statistics relative to the foreign trade of Great Britain in natural iron oxide pigments do not separate them into their respective classes but group them all under the heading of "Ocher and Earth Colors." Data secured from American consular offices in England show that during the five-year period, 1925-1929, British imports of iron oxide, principally from Spain, ranged from 4,473 to 6,498 long tons annually.

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Table 13. - Imports of ocher and earth colors into Great Britain, long tons 1/

Origin	1925	1926	1927	1928	1929
Germany	1,538	2,574	3,090	2,019	2,113
Holland	399	212	918	254	221
Belgium	249	236	381	400	289
France	2,464	2,741	2,855	2,803	2,763
Spain	6,498	5,973	4,359	4,966	4,473
Italy	866	694	841	865	1,021
Persia	6,496	---	318	5,310	2,532
United States	2,701	2,867	2,752	4,943	2,476
Cyprus	968	1,056	820	1,525	1,398
South Africa	2/	15	---	137	802
India	497	573	573	475	599
Other countries					
Total	23,285	20,204	17,539	21,882	19,606
Total value, pounds sterling	216,616	189,629	156,087	190,203	181,115

1/ Annual Statement of the Foreign Trade of the United Kingdom, Volume 2.
2/ Less than 1 ton.

Table 14. - Exports of domestic ocher and earth pigments by Great Britain, long tons 1/

Destination	1926	1927	1928	1929	1930
Sweden	118	111	181	175	301
Germany	453	931	614	487	436
Holland	462	579	456	383	345
Belgium	642	587	351	488	581
France	377	684	524	657	620
Spain	74	83	77	95	82
Italy	117	197	261	187	146
United States	2,912	2,621	2,704	2,767	1,884
Chile	84	85	82	99	58
Argentine	401	392	351	381	381
Irish Free State	265	404	390	363	342
South Africa	949	1,138	1,072	1,074	746
India	561	672	688	468	517
Australia	599	830	730	794	500
New Zealand	227	258	259	230	220
Canada	504	498	691	695	495
Other countries					
Total	10,398	11,956	11,805	11,285	9,380
Total value, pounds sterling	252,695	275,188	262,071	249,878	188,915

1/ Annual Statement of the Foreign Trade of the United Kingdom, Volume 2.

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Table 15. - Re-exports (of foreign origin) of ocher and earth colors by Great Britain, long tons 1/

Destination	1925	1926	1927	1928	1929
United States	918	68	26	10	716
Other foreign countries	390	385	39	45	345
Other British countries	121	108	118	111	90
Total	1,429	561	183	166	1,151
Total value, pounds sterling	13,581	8,663	3,617	3,110	8,424

1/ Annual Statement of the Foreign Trade of the United Kingdom, Volume 2.

Canada

The Canadian paint industry relies to a considerable extent upon imports, especially from the United States, for a large proportion of its raw materials, both in the natural state and in prepared form ready for grinding and mixing. The iron oxide pigment industry is centered in the Province of Quebec in close proximity to American industrial centers. Certain quantities of the Canadian output, thorefore, find a market in the United States. In 1929, 6,518 tons of oxide pigments, valued at $116,000, was produced.23/ Table 16 shows the quantity and value of materials used in the manufacture of iron oxide paints in Canada for the years 1922 to 1927, inclusive, the only years for which figures are available:

Table 16. - Materials used in the manufacture of iron oxide paints in Canada 1/

	Iron oxide ore		Iron oxide pigments		Ochers, siennas, and umbers	
	Quantity, pounds	Cost at works	Quantity, pounds	Cost at works	Quantity pounds,	Cost at works
1922	54,628	$ 3,280	2,508,463	$ 102,711	1,289,640	$ 81,216
1923	163,615	5,238	2,209,302	94,083	1,686,311	82,703
1924	64,609	3,514	1,790,097	59,451	1,490,582	63,818
1925	142,479	6,751	1,758,738	59,962	1,572,260	53,557
1926	57,000	1,788	2,390,085	87,959	1,679,871	59,065
1927	997,165	23,481	1,801,159	73,395	1,611,096	68,872

1/ Chemical and Allied Products, Canadian Dominion Bureau of Statistics.

23/ Wood, E. C., and Kiefer, E. A., Work cited.

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LIST (INCOMPLETE) OF DOMESTIC PRODUCERS, DEALERS, AND IMPORTERS OF IRON OXIDE PIGMENTS

Acheson Graphite Corporation, Niagara Falls, N. Y.
C. K. Williams, Easton, Pa.
Reichard-Coulston (Inc.), 95 Madison Ave., New York City.
W. P. Fuller & Co., San Francisco, Calif.
The Synthetic Iron Color Co., Richmond, Calif.
Smith Chemical & Color Co., 28 Moore St., New York City.
E. M. & F. Waldo, Inc., Muirkirk, Md.
Clinton Metallic Paint Co., Clinton, New York.
Jos. A. McNulty, 114 Liberty St., New York City.
Seminole Pigment Co., Allentown, Pa.
Geo. B. Smith, Chemical Works, Springfield, Ill.
A. Daigger & Co., 159 W. Kinzie St., Chicago, Ill.
Stanley Doggett (Inc.), 99 John St., New York City.
Paint Pigment Co. of America, 412 Reading Road, Cincinnati, Ohio.
Ricketson Mineral Color Works, Milwaukee, Wis.
Siemon & Elting, Irvington, N. J.
Geo. S. Mepham & Co., East St. Louis, Ill.
Heller & Merz Corp., 505 Hudson St., New York City.
West Boyd Chemical Co., 808 N. Clark St., Chicago, Ill.
C. M. Durbin Co., Cincinnati, Ohio.
Manufacturers Mineral Co., Seattle, Wash.
Georgia Peruvian Ocher Co., Cartersville, Georgia.
New Riverside Ocher Co., do.
Cherokee Ocher Co., do.
E. I. du Pont de Nemours & Co., Wilmington, Del.
Frazer Paint Co., Detroit, Michigan.
General Metallic Oxides Co., Jersey City, N. J.
May Chemical Works, Newark, N. J.
American Pigment Corporation, Bedford, Va.
Blue Ridge Talc Co., Henry, Va.
Winters Metallic Paint Co., Mayville, Wis.
Binney-Smith Co. (Inc.), 44 - E. 43rd St., New York City.
Penn Ore Co., DuBois, Pa.
J. Lee Smith & Co., 23 Jacob St., New York City.
International Silica Co., Cairo, Ill.
Imperial Color Works, Glenn Falls, New York.

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